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DISCOVERY OF THE NORMANSKILL GRAPTOLITE FAUNA IN THE ATHENS SHALE OF SOUTH- WESTERN VIRGINIA

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During the last year, as opportunity was afforded, the writer has had under investigation a Cambro-Ordovician section in southwestern Virginia, not only as a contribution to our knowledge of the geology of this section of Virginia, but more especially for the purpose of correlation, if possible, with the standard section north. In connection with this work the discovery was made that the Athens shale abounds in graptolites. The determination of some thirty or more species and varieties shows that the majority, if not all, are the same as those which characterize the Normanskill shale of New York.

As the paper on the entire Cambro-Ordovician section will not appear for some months, this occurrence is thought of sufficient moment to warrant the publication of this note in advance.

A number of papers have appeared in recent years discussing the Normanskill graptolite fauna and the correlation of the shales containing it. The literature on the subject shows that the formation has, from time to time, been referred to every possible position from the Hudson River formation to the Chazy. In 1901, however, Dr. Ruedemann showed¹ that the slate which contains this fauna in the Hudson River region underlies the Utica slate, and correlated it with the lower or middle Trenton. This correlation, based almost entirely on paleontologic evidence, is in general accordance with the views held by R. R. Gurley, H. M. Ami, and Charles Lapworth. Later, in 1903, Weller found the fauna in New Jersey, and, from his study of the beds containing it, concluded that they are about equivalent to the middle portion of the

¹ *Bull. 42, N.Y. State Mus.*

typical Trenton limestone of New York, or even to a position below the middle.

Dr. Emmons long ago expressed the belief that the formation extended through to Virginia, but very little is reported of it from the south. Professor E. A. Smith, state geologist of Alabama, reports a small fauna of about eight species occurring in calcareous shale associated with Trenton limestone, which he believes to be upper Trenton. This find, however, could demonstrate nothing more than the general fact of the Trenton age of the Normanskill fauna. Stratigraphic proof of the age of the formation has not been found in New York for the reasons stated by Ruedemann, that the whole mass of rocks, which contains Trenton, Utica, and Lorraine beds in similar lithologic development, is in New York as well as in Canada cut off from the neighboring terranes by extensive faults, thus apparently frustrating all attempts at a stratigraphic solution of the problem. As the primary object of this preliminary note, in addition to calling attention to the many species of graptolites occurring here, is definitely to locate on stratigraphic grounds the exact position of the formation containing this fauna, a description of the relevant portion of the section is given.

The Cambro-Ordovician section under investigation is in Roanoke County, Virginia, about 11 miles north of Salem, and extends from the top of Catawba Mountain northward across Catawba Valley to the foot of North Mountain, a distance of about 6,000 feet. This section is characterized by the unusual occurrence of all the strata from top to bottom in regular chronologic order, there being no faults or folds to disturb the natural sequence. Furthermore, the strata are most favorably disposed for observation, dipping at an angle of 45° on Catawba Mountain, and gradually rising to 70° in the valley. The new state road just being graded down the side of the mountain and across the valley exposes every stratum in the section from the top of the Medina on the south face of Catawba Mountain to the base of the Cambrian at the foot of North Mountain.

At the latter point there is a fault bringing the Carboniferous in conjunction with the Cambrian, which terminates the section. The section therefore includes every stratum from the top of the

Medina to the base of the Cambrian, with each in practically normal development. The section embraces the following members:

Medina sandstone, gray sandstone, quartzitic	400-500 feet
Sevier shales, calcareous shales and sandstones, and bluish-gray impure limestone. All very fossiliferous	1,200 feet
Utica shale, fossiliferous blue to black shales, and limestones with shale partings	300 feet
Tellico sandstone, red and gray sandstones	400 feet
Trenton, dark gray-blue, and black limestones with shale partings	500 feet
Athens shale, black carbonaceous shales, carrying graptolites, trilobites lingulas	560 feet
Black River, coarse dark coralline limestone with bands of smoky marble in upper part	250 feet
Birdseye (Lowville), pure dove limestone, with Tetradium	50 feet
Chazy, cherty magnesian limestone, with <i>Maclurea magna</i>	500 feet
Beekmantown, pure and impure, cherty and magnesian limestone	1,700 feet

As the Ordovician is now known to extend as far south as Alabama, evidenced by the finding of Ordovician graptolites by Professor E. A. Smith, and as the writer has found Ordovician fossils in the black slates in eastern Virginia, and as the Ordovician is known to occur far to the north and west of this point, it is but fair to presume that the sediments represented in the rocks of this section were laid down far within the confines of that ancient sea and that the section is therefore in normal development. Furthermore, as will presently be shown, the fossils—graptolites and others—occurring here are the same as those found in equivalent strata in New York and Canada, and Dr. Ruedemann makes the statement that the essential identity of the Alabama fauna with the Normanskill graptolite fauna cannot be gainsaid. It therefore seems most probable that the sea was open and continuous from Alabama to Canada, and that sedimentation was virtually the same throughout. The section here should, therefore, be practically the same as in New York. A notable difference occurs in the Tellico sandstone, which, however, may be but an expansion of the Dolgeville shale, a name proposed by Cushing in 1909 for the shaly phase of the upper Trenton which he previously described as “Trenton Utica passage beds.” It may therefore be stated with greater

confidence that the Catawba section is normal and in general accord with the section north.

The Utica consists of two parts. The upper is slaty or shaly and more or less calcareous, carrying several species of corals and brachiopods, while the lower part is slaty limestone and limestone beds with some shale partings. The thin beds, which vary in thickness from one to four inches, are largely made up of brachiopods. The Tellico beneath is composed of red and gray sandstone and shale, with a massive, hard, quartzitic, ferruginous sandstone 30 feet thick at its base. It carries in addition some kaolin and flakes of mica. This basal member rests immediately upon the Trenton. The formation is about 300 feet thick. The Trenton limestone is conformable with the Tellico above, the two dipping at an angle of 60° S. The contact between them is sharp and clear. The limestone ceases suddenly as the sandstone comes in. The upper part of the Trenton consists of rather massive, dark, blue-gray limestone with some thin shale partings. The lower part is made up of alternating layers of solid black homogeneous limestone and thin bands of slate, the limestone bands varying in thickness from two to four to six inches. Fossils have not been observed except near the contact with the Athens shale, where a number of small trilobites were found. These probably belong to the Athens shale as the same species have since been found in the lower part of it. The Trenton formation is 500 feet thick, and passes into the Athens shale without perceptible break. Fresh-rock contact, however, has not been observed. On the surface there is frequently a slight depression due to differential weathering marking the contact. The Athens formation is compact, black, carbonaceous shale, slightly calcareous. The lower part contains some layers which are massive, and which resemble the Trenton limestone; but on examination the lime content is found to be no greater than in the more shaly portion above. The massive character is found to be due to less pressure having been applied to this part of the formation. It contains innumerable forms of *Dicellograptus sextans* which are not at all crushed or flattened, while the graptolites in the upper part of the formation are more or less flattened. These forms look as if they could be taken out bodily and sections of them be made for

microscopic study. The fossils show a smooth, polished, black, chitinous surface. Near the middle of the formation along with the various species of graptolites there are many forms of *Triarthrus becki*, and *Leptobolus walcotti*.

In New York the formation—Normanskill—carrying the same fossils is described by Ruedemann as a deep bluish-black, thick-bedded argillite with conchoidal fracture, and iron-stained cleavage. This description applies equally well to the Athens shale of Virginia. In *Folio 16 U.S.G.S.* Keith says of the Athens shale in Tennessee: "It is everywhere composed of blue and black shales, which do not vary in appearance. The black shales are found at the bottom of the series and contain lingula and numerous graptolites. The blue shales gradually replace the black shales in passing up through the series, and when fresh consist of thin light blue, shaly limestones." It is evident that the blue shales above the black, which he says consist of thin, light-blue, shaly limestone, represent the Trenton in that section, and the black shales below with the included graptolites and lingulae represent the Athens. Keith, in that section, also represents the Athens shale as immediately underlying the Tellico sandstone. Immediately below the Athens shale he describes a limestone formation consisting of massive blue and gray limestones, shaly and argillaceous limestones, and marbles. These beds are all very fossiliferous, and fragments of corals, crinoids, brachiopods, and gastropods are so abundant as sometimes to make most of the bulk of the rock. The upper beds of the formation consist of more or less coarsely crystalline marble. This is exactly the position of the marble beds in the Black River formation, and anyone at all familiar with it will see at once from the above description that the Athens shale of Tennessee, as well as that in Virginia, rests upon the Black River.

The conglomerate R. Ruedemann described¹ as occurring in the Normanskill of New York, although looked for, was not observed. Neither does the Rysedorph conglomerate occur here, which Ruedemann describes as intercalated in undoubted Normanskill, and containing in pebbles as well as matrix, as its youngest fossils, those of lower Trenton aspect. There does occur here, however,

¹ *Bull. 42, N.Y.S.M.*

a conglomerate at the base of the Lowville (Birdseye), separating it from the Chazy, which is in many respects like the Rysedorph conglomerate, but not in fossil content. While not essential to the points involved in this note, yet, for the sake of clearness, a brief description of it will be given when that point is reached in describing the section.

The mass of the Athens shale (Normanskill) dips at an angle of 70° S., and is about 550 feet thick. It occupies the center of Catawba Valley, which structurally is anticlinal, and through which meanders Catawba Creek. The shales where exposed in bluffs weather into thinly cleaved plates or leaves of a dark peppery gray on which the graptolites are not readily observed. The completely weathered soil is ochereous yellow, due to the presence of iron in the original rock. The fossils are in places preserved in pyrite, and as a rule where the seams open upon weathering the surface is rusty. On such surfaces the black fossils stand out clearly. The formation maintains its general character throughout, and terminates abruptly against the underlying Black River limestone, and does not here rest upon lower Trenton limestone. In this respect its position differs from the Normanskill of New York, for Ruedemann states in his summary that these shales rest on lower Trenton limestones. Mather, however,¹ in describing the Black River, in which is included the Lowville, several times states that the Black River is underlaid by a brecciated limestone and overlaid by slates. It would appear, therefore, that in certain localities, at least in New York, the succession of strata for this part of the Ordovician is the same as in Virginia; for these Black River limestones and slates of which Mather writes occur at Mount Moreno, and Mount Moreno is one of the four typical localities where complete or nearly complete Normanskill faunas have been collected. The conclusion to be drawn from the above is that the Normanskill there rests on Black River limestone as in Virginia.

The question has also arisen whether the Normanskill is a distinct development of the Ordovician or only a clastic phase of the Trenton. For this locality at least, it would appear to represent a distinct epoch in the Ordovician; for the formation is at least

¹ *Nat. Hist. N.Y.*, Part IV, "Geology," pp. 405-6.

500 feet thick, which is as thick as the Trenton above, and maintains its individual character throughout, in respect to lithology as well as fossil content. While no decided break or hiatus has been observed between it and the Trenton, yet there is a marked change in sedimentation. The shale deposit ceases and limestone appears, and along with it an entire change of life. Between it and the formation below the change in sedimentation is still more marked, for the fine black sediment of the Athens shale rests immediately upon the thoroughly crystalline limestone and marble of the Black River. The feature that would most closely associate the Athens shale with the Trenton is the occurrence of *Triarthrus becki* in the shale, but while it has been reported from the Trenton of other localities, it has not been observed to occur in the Trenton at this point. The Trenton here is singularly devoid of fossils. Everything considered, conditions here point to the same conclusion for the Athens shale as those reached by Lapworth, Ami, and Ruedemann for the Normanskill of New York, viz., that it represents a distinct epoch of the Ordovician.

The species of graptolites and other forms from the Athens shale thus far determined are as follows:

- Climacograptus bicornis Hall
- Climacograptus modestus
- Climacograptus parvus Hall
- Climacograptus putillus Hall, mut. eximus
- Climacograptus putillus Hall
- Climacograptus scalaris
- Climacograptus typicalis Hall, mut. spinifer
- Climacograptus scharenbergi Lapworth
- Corynoides gracilis Hop., mut. perungulatus
- Cryptograptus tricornis Carruthers
- Dicellograptus sextans Hall
- Dicellograptus intortus Lapworth
- Dicranograptus spinifer Lapworth
- Dicranograptus nicholsoni Hopkins
- Dicranograptus ramosus Hall
- Didymograptus serratulus Hall
- Didymograptus sagittacaulis Gurley
- Didymograptus subtenuis Hall
- Diplograptus amplexicaulis Hall
- Diplograptus angustifolius Hall

Diplograptus foliaceus var. incisus
Diplograptus foliaceus Murchison, var. acutus Lapworth
Diplograptus foliaceus
Dictyonema ———
Glossograptus quadrimucronatus Hall, var. cornutus
Lasiograptus mucronatus Hall
Leptobolus walcotti
Nemagraptus exilis Lapworth
Nemagraptus exilis Lapworth, var. linearis
Nemagraptus gracilis Hall
Phycograptus laevis (Graptolithus laevis Hall)
Retiograptus eucharis Hall
Triarthrus becki

An interesting feature of a number of these species is their occurrence in original colonies, or synrhabdosomes. Several species show synrhabdosomes which have not heretofore been observed. All of the above listed forms occur in fresh material, are very distinct, and apparently not at all distorted, or flattened. The graptolites occur in all parts of the formation from top to bottom.

The Black River formation beneath the Athens shale is made up of dark to black coarsely crystalline limestone and marble, 250 feet thick. It contains several distinct bands of marble between the middle and the top. One occurs at the top. The marble is of a smoky-gray color, rather coarsely crystallized, and fossiliferous. The bed near the middle is about 6 feet thick, the other beds somewhat less. The mass as a whole, except the lower part, appears to be a coral reef on which flourished crinoids, bryozoa, brachiopods, gastropods, and, in the lower part, orthoceratites. The lower part of the formation is more or less siliceous and cherty, which on weathering produces knots over the surface. The Black River was laid down on an unevenly eroded surface of dove-colored limestone, the Lowville (Birdseye). The hiatus here shown is well marked. A sharp line can be drawn between the coarse, dark, impure limestone above and the pure fine-grained, dove-colored limestone beneath. The Lowville contains *Tetradium cellulosum* in abundance, and near the bottom large, coiled shells. The formation is about 50 feet thick and terminates in a very coarse, brecciated limestone conglomerate, which separates it from the Chazy below.

This appears to be a basal conglomerate. It is composed of fragments ranging in size from an eighth of an inch to pieces 6×15 inches. They consist of angular grains and pebbles of quartz, pieces of dark chert 4×6 inches, large blocks of magnesian limestone, and angular fragments of all sizes from the underlying cherty magnesian limestone of the Chazy and Beekmantown formations. The fossils, among them *Ophileta*, are imbedded in such a manner with the fragments as to indicate that they were fossils when inclosed. The conglomerate is from 6 to 8 feet thick. This evidently is the conglomerate referred to by Mather as occurring at Mount Moreno. It is in all probability the basal conglomerate described by Weller from New Jersey. The writer has noted its occurrence in Maryland and at several places here in southwestern Virginia. It has been observed here at two points, in the same stratigraphic position, 12 miles apart at right angles to the strike, showing that the sea was encroaching upon the land, beating down the ancient Chazy-Beekmantown limestone cliffs, and scattering the fragments along the shore from Canada to Tennessee¹ as the sea advanced.

Enough of the section has now been described to locate definitely the stratigraphic position of the shales carrying the Normanskill graptolite fauna. It is evident that the position assigned them here, below the Trenton and above the Black River, is correct for Virginia and Tennessee, and is in harmony with the statement of Mather for part of New York. It is also in general accord with the views entertained by Ami, Lapworth, and Gurley, who, on paleontologic evidence only, thought the fauna should be placed in lower Trenton if not below the Trenton.

Dr. Ruedemann² admits the essential identity of the Alabama fauna with the Normanskill, but says it is open to question whether this upper Trenton of Alabama is exactly equivalent to that of New York. In the light of the manifestly clear section in southwestern Virginia, it is difficult to see how these same shales could be upper Trenton in Alabama. Furthermore, the section as given

¹ Keith describes a similar conglomerate "of unknown age" from that state, which, from his description (*U.S. Folio 16*), is in all probability the same.

² *Mem. II, N.Y.S.M.*, p. 12.

by Professor Smith reads as if the strata were very much faulted, folded, or otherwise disturbed. The graptolite beds are seen to be alternating with beds of chert and sandstone, and they are stated to occur at the top of the series, not far below chert beds with sub-Carboniferous fossils. The latter indicates either profound thrust faulting or an interval of non-deposition.

While the evidence gathered by those who, in the North, have been wrestling with the problem of the age and stratigraphic position of the Normanskill graptolite fauna points to nothing more definite than probably lower Trenton, and no further extension south than the present site of New Jersey in the Appalachian geosyncline, it is believed that the facts here presented definitely fix both age and position, and at the same time show a southern extension as far as Tennessee.

SUMMARY

The great number of graptolites occurring in the Athens shale of Virginia, and the fact that nearly all of those thus far identified are Normanskill forms, leaves no doubt as to the identity of this fauna with that of the Normanskill. The Athens shale carrying this fauna is to be correlated with the Normanskill shale of New York.

The stratigraphic position of the Athens shale in southwestern Virginia is clearly below the Trenton and above the Black River, and it seems probable that when discovered at points intermediate it will be found to occupy the same position.